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10/696,693	10/29/2003	Michael Shur	SETI-0007	5258

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EXAMINER	
DICKEY, THOMAS L	

ART UNIT	PAPER NUMBER
2826	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

PTOCommunications@hoffmanwarnick.com

Office Action Summary	Application No. 10/696,693	Applicant(s) SHUR ET AL.	
	Examiner Thomas L. Dickey	Art Unit 2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on _16 January 2009_.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-3,7,8,10,11,13-17,20,21,23-26,28 and 29_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) _23_ is/are allowed.

6)☒ Claim(s) _1-3,7,8,10,11,13-17,20,21,24-26,28 and 29_ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _29 October 2003_ is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. The amendment filed 01/16/2009 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

A. Claims 1-3, 7, 8, 10, 13-17, 20, 24-26, and 29 stand rejected under 35 U.S.C. 103(a) as being unpatentable over RYZHII ET AL., "Terahertz photomixing in quantum well structures" J. App. Phys. Vol. 91 p. 1875 (2002) in view of SARUKURA ET AL., "Submilliwatt, short-pulse, terahertz radiation from femtosecond-laser irradiated InAs in a magnetic field", Lasers and Electro-Optics, 1998. In the examiner's opinion, this/these claim(s) would have been obvious according to one of the rationales expressed in the *Examination Guidelines for Determining Obviousness Under 35 U.S.C. 103 in View of*

the Supreme Court Decision in KSR International Co. v. Teleflex Inc., as published at 72 Federal Register 57526 et seq.[1] (10/10/2007).

The Guidelines explain that an invention that would have been obvious to a person of ordinary skill at the time of the invention is not patentable. The Guidelines point out that, as reiterated by the Supreme Court in KSR, the framework for the objective analysis for determining obviousness under 35 U.S.C. 103 is stated in *Graham v. John Deere Co.* Obviousness is a question of law based on underlying factual inquiries. The factual inquiries enunciated by the Court are as follows:

(1) Determining the scope and content of the prior art;
(2) Ascertaining the differences between the claimed invention and the prior art, and
(3) Resolving the level of ordinary skill in the pertinent art.

Examining this last factor first, it is noted that any obviousness rejection should include, either explicitly or implicitly in view of the prior art applied, an indication of the level of ordinary skill. This is an essential finding because (as the Guidelines point out) a finding as to the level of ordinary skill may be used as a partial basis for a resolution of the issue of obviousness. The person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. Factors that may be considered in determining the level of ordinary skill in the art include:

[1] Available at http://www.uspto.gov/web/offices/com/sol/notices/72fr57526.pdf

(1) “Type of problems encountered in the art;”
(2) “prior art solutions to those problems;”
(3) “rapidity with which innovations are made;”
(4) “sophistication of the technology;” and
(5) “educational level of active workers in the field.”

In a given case, every factor may not be present, and one or more factors may predominate. In the present case, Applicant has presented claims to a device classified in Class 257 (Semiconductor Devices). Evaluating the level of skill with reference to the five factors, the Examiner finds:

(1) The types of problems encountered in Class 257 typically are highly complex, involving questions of electrodynamics, thermodynamics, crystallography, and quantum mechanics.

(2) Prior art solutions to problems presented in this field demonstrate thinking of the highest order. Many prior art solutions in this field have won Nobel prizes. Past Nobel prizewinners for Class 257 innovations include John Bardeen, William Schockley, Jack Kilby, Leo Esaki, Nick Basow, Zhores Alferov, Pierre-Gilles de Gennes, and probably a half dozen[2] more this writer has forgotten.

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[2] On reflection, this writer can only recall five more Nobel Prizes awarded to individuals in recognition of their providing valuable prior art solutions to problems in the semiconductor arts: Herbert Kroemer, winner of the 2000 Nobel prize recognizing the heterojunction semiconductor laser as a valuable prior art solution, Albert Fert and Peter Grünberg, recognized for Giant Magnetoresistance (valuable in the field of semiconductor memories), Walter Houser Brattain, recognized for a prior art solution, known as the "transistor effect," which has proven to be of some small value to humankind; and Klaus von Klitzing, discoverer of the quantum Hall

The Nobel Prize committee is not, of course, the only organization recognizing valuable prior art solutions to class 257 problems. For example, in 2003 the magazine Compound SemiNews recognized Shuji Nakamura, Michael Shur, Norm Schumaker, John Edmond, and Bob Steele for their extremely valuable ("valuable", as defined by Compound SemiNews, means potential financial value in the billions of dollars) semiconductor solutions in the III-nitride blue LED field. In "Pioneering the Blue Spectrum," editor Jo Ann McDonald explained, "Blue spectrum solid state light emitting diodes (LEDs) and laser diodes (LDs) made of Group III nitride materials, are revolutionizing the world of lighting and optical storage. The history of their evolution is the classic '20 year overnight success' story. The visionaries who pioneered the commercial applications kept chipping away and, finally, in 2003 the blue spectrum industry is tapping the Mother Lode." See http://www.compoundsemi.com/news/pdf/blue2003pioneers.pdf.

Other evidence of valuable prior art solutions in the semiconductor art may be found in a 2002 press release from Sensor Electronic Technology, Inc. (SET). In this release, SET explains, "The development of semiconductor-based UV light sources is of critical importance to the military. Miniaturized UV light sources have application in biological agent detection, nonline-of-sight (NLOS) covert communications, water purification,

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effect. So it turns out this writer had only forgotten the valuable prior art semiconductor solutions made by five Nobel Prize winners,

equipment/personnel decontamination, and white light generation." SET explains, further, that the Defense Advanced Research Projects Agency (DARPA) "is interested in exploiting 'the unique characteristics of wide bandgap semiconductors to produce optical sources operating in the ultraviolet portion of the spectrum that can be integrated into modules and subsystems to address these applications.'" The SET press release provides more evidence of the highly useful nature of prior art solutions in the semiconductor arts, as well as of the value assigned to such prior art solutions by grant-making agencies such as DARPA. See http://compoundsemiconductor.net/cws/article/news/16457.

Note also that recently, while examining the last two decades of progress in the semiconductor art, the New York Times commented, "If innovation has a heart, it's probably a semiconductor, beating to the pace of Moore's Law." See "Trying to Put New Zip Into Moore's Law"[3]

(3) Innovations in Class 257 are made extremely rapidly (see, e.g. "Moore's Law").

(4) Technology used to make and practice inventions in this field are highly sophisticated. Some "fabs" (as those of skill in the art call the factories for making these devices) now cost in excess of three billion dollars each, and perform literally hundreds of billions of operations per hour.

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not half a dozen.

(5) Finally, the educational level of active workers in this field is extremely high – Ph.D.s are common, and a bachelor's degree in engineering is the absolute minimum educational level of workers in this field.

In short, the level of ordinary skill in this field is extremely high. In *KSR* (while considering an invention involving the substitution of one simple mechanical linkage for another), the Supreme Court cautioned, "A person of ordinary skill is also a person of ordinary creativity". *KSR Int'l Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1742, 82 USPQ2d 1385, 1397 (2007). Had the Court been looking at the variety of extraordinarily valuable (from lifestyle-changing, such as high-speed communications and computing, to handy devices such as IPods and cellphones) and difficult solutions to challenging problems that have been accomplished in the semiconductor art in recent years, the Court might easily have said that in the semiconductor art the person of ordinary skill is a person of extraordinary creativity.

Next, we consider the first and second factual findings required by *Graham*. With regard to claims 1-3, 7, and 24, the scope and content of the prior art includes, in the Ryzhii et al. disclosure, a description of a method of managing terahertz radiation, the method comprising: providing a semiconducting device having a two-dimensional carrier

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[3] New York Times, 2/28/08 (http://www.nytimes.com/2008/02/24/business/24proto.html?_r=1&th)

gas (in the QW channel, as Ryzhii et al. explicitly discloses at the second column of page 1881) and comprising (note figure 1) a field effect transistor; exciting the carrier gas by shining a laser having an energy higher than 1.42 eV (the energy required to achieve a transition from bound states to continuum states, note the left column of page 1876) directly onto a bottom side of the semiconducting device; and adjusting a frequency of the radiation to a desired frequency using a gate bias voltage (the top of the right column of page 1876 states, “Due to the dependence of Σ on the bias voltages, the plasma resonances are voltage tunable”) applied to the semiconducting device. Note figure 1 and pages 1875-1876 and 1881 of Ryzhii et al. The difference between the prior art method disclosed by Ryzhii et al. and the method of claims 1-3, 7, and 24 is that, where claims 1-3, 7, and 24 require a step of generating a 1-10,000 femtosecond laser pulse with a laser, Ryzhii et al.’s method includes a step of shining two lasers with a difference frequency.

With regard to claim 8 the scope and content of the prior art includes, in the Ryzhii et al. disclosure, a description of a method of generating radiation using a field effect transistor, the method comprising: shining a laser directly onto a gate (indicated in figure 1(b) as “Gate”) of the field effect transistor; and adjusting a frequency of the radiation to a desired frequency by adjusting a gate length for the gate (note the bottom of the left

column of page 1876, stating, "The resonant plasma frequencies are determined by the length of the QW channel (2*L*)") to adjust a carrier density of carriers in a channel of the field effect transistor. Note figure 1 and pages 1875-1876 of Ryzhii et al. The difference between the prior art method disclosed by Ryzhii et al. and the method of claim 8 is that, where claim 8 requires a step of generating a laser pulse with a laser, Ryzhii et al.'s method includes a step of shining two lasers with a difference frequency.

With regard to claims 10 and 13 the scope and content of the prior art includes, in the Ryzhii et al. disclosure, a description of a method of generating terahertz radiation comprising the steps of shining a laser directly onto a transparent gate (indicated in figure 1(b) as "Gate") of a field effect transistor; and adjusting a frequency of the radiation (note the bottom of the left column of page 1876 ["The resonant plasma frequencies are determined by the length of the QW channel (2*L*) and the electron sheet concentration in it (Σ)"] and the top of the right column ["Due to the dependence of Σ on the bias voltages, the plasma resonances are voltage tunable"]) to a desired frequency by adjusting a carrier density of carriers (note, again, that Ryzhii et al. teaches changing the sheet carrier density (Σ) by adjusting the bias voltages) in a channel of the field effect transistor. Note figure 1 and pages 1875-1876 of Ryzhii et al. The difference between the prior art method disclosed by Ryzhii et al. and the method of claims 10 and 13 is that, where

claims 10 and 13 require a step of generating a laser pulse with a laser, Ryzhii et al.'s method includes a step of shining two lasers with a difference frequency.

With regard to claims 14 and 29 the scope and content of the prior art includes, in the Ryzhii et al. disclosure, a description of a method of generating radiation comprising shining a laser pulse directly onto a gate of a field effect transistor; and adjusting a frequency of the radiation to a desired frequency by adjusting a carrier density of carriers in a channel of the field effect transistor, wherein the shining excites plasma oscillations and wherein an active layer in the field effect transistor traps the plasma oscillations as plasma waves. The difference between the prior art method disclosed by Ryzhii et al. and the method of claims 1-3 and 7 is that, where claims 14 and 29 require a step of generating a 1-10,000 femtosecond laser pulse with a laser, Ryzhii et al.'s method includes a step of shining two lasers with a difference frequency.

With regard to claims 15-17, 20, 25, and 26 the scope and content of the prior art includes, in the Ryzhii et al. disclosure, a description of a method of generating terahertz radiation using a heterodimensional diode comprising the steps of shining a laser directly onto a bottom side of a substrate of a heterodimensional diode including an ohmic contact (side contacts shown in figures 1(a) and 1(b) and described in the left column of page 1876) and a rectifying contact (the Schottky collector described in the left column

of page 1876); and adjusting a frequency of the radiation to a desired frequency using a voltage applied (the top of the right column of page 1876 states, “Due to the dependence of Σ on the bias voltages, the plasma resonances are voltage tunable”) to the heterodimensional diode to adjust a frequency of a plasma wave in a two-dimensional carrier gas in the heterodimensional diode. Note figure 1 and pages 1875-1876 and 1881 of Ryzhii et al. The difference between the prior art method disclosed by Ryzhii et al. and the method of claims 15-17, 20, 25, and 26 is that, where claims 15-17, 20, 25, and 26 require a step of generating a 1-10,000 femtosecond laser pulse with a laser (as well as a second such pulse), Ryzhii et al.’s method includes a step of shining two lasers with a difference frequency.

The difference between the prior art method disclosed by Ryzhii et al. and the method of any of claims 1-3, 7, 8, 10, 13-17, 20, 24-26, and 29 is therefor that, where these claims require a step of generating a 1-10,000 femtosecond laser pulse with a laser (and including multiple pulses in claims 15-17, 20, 25, and 26), Ryzhii et al.’s method includes a step of shining two lasers with a difference frequency. Ryzhii et al. does teach (note the first column of page 1875) that optical techniques using a coherent output at the difference frequency equal to the difference between the frequencies of radiation emitted by two lasers (as Ryzhii et al. does) or a response of photoconductive

structures to femtosecond optical pulses (as is claimed) are, in Ryzhii et al.'s words, "Alternative approaches."

Sarukura et al. discloses a method of generating radiation including a step of generating a series of 70 femtosecond laser pulses with a laser and shining the laser pulses onto a III-V target. Sarukura et al.'s method produces a tunable THz source in the 0.5–3 THz region by shining a laser onto a III-V semiconductor target. Note figures 2A-2B and the second paragraph of Sarukura et al. The question is, taking into account the high level of education, skill, and creativity of one of ordinary skill in the semiconductor art, would it have been obvious to achieve the invention of claims 1-3, 7, 8, 10, 13, 14, and 29 by substituting the step of step of generating a series of 70 femtosecond laser pulses with a laser taught by Sarukura et al. for Ryzhii et al.'s step of shining two lasers with a difference frequency?

To reject a claim based on the basis of the rationale expressed in section IIIB of the *Examination Guidelines*, Office personnel first must resolve the Graham factual inquiries (as has just been done). Office personnel must then articulate the following:

> (1) a finding that the prior art contained a device (method, product, etc.) which differed from the claimed device by the substitution of some components (step, element, etc.) with other components;
>
> (2) a finding that the substituted steps and their functions were known in the art;
>
> (3) a finding that one of ordinary skill in the art could have substituted one known element for another, and the results of the substitution would have been predictable; and

> (4) whatever additional findings based on the *Graham* factual inquiries may be necessary, in view of the facts of the case under consideration, to explain a conclusion of obviousness.

As explained above, Ryzhii et al. discloses a method that differed from the claimed device only by the substitution of some steps (a step of generating a series of 70 femtosecond laser pulses with a laser) for other steps (a step of shining two lasers with a difference frequency). Sarukura et al. discloses that the substituted steps and their functions were known in the art. Further, Sarukura et al. discloses that those of skill in the art were familiar with a method combining the step of generating a series of 70 femtosecond laser pulses with a laser with a method (producing a tunable THz source in the 0.5–3 THz region by shining a laser onto a III-V semiconductor target) palpably similar to Ryzhii et al.'s method. From the similarities between Sarukura et al.'s method and Ryzhii et al.'s method, one of skill in the art would have been able to conclude that the step of generating a series of 70 femtosecond laser pulses with a laser could have substituted for the step of shining two lasers with a difference frequency of Ryzhii et al.'s method. One of skill in the art would have had reason to predict (based on its functioning in combination with Sarukura et al.'s method) that the step of generating a series of 70 femtosecond laser pulses with a laser would have continued functioning much as it did in combination with Sarukura et al.'s method, and that after the substitution, Ryzhii et al.'s method would continue functioning in the manner disclosed by Ryzhii et al. It

would therefore have been obvious to a person having skill in the art to modify Ryzhii et al.'s method by substituting the step of generating a series of 70 femtosecond laser pulses with a laser taught by Sarukura et al. for Ryzhii et al.'s step of shining two lasers with a difference frequency.

B. Claims 11, 21 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over RYZHII ET AL., "Terahertz photomixing in quantum well structures" J. App. Phys. Vol. 91 p. 1875 (2002), in view of SARUKURA ET AL., "Submilliwatt, short-pulse, terahertz radiation from femtosecond-laser irradiated InAs in a magnetic field", Lasers and Electro-Optics, 1998, and PERALTA ET AL., "Terahertz photoconductivity and plasmon modes in double-quantum-well field-effect transistors" Appl. Phys. Lett. Vol. 81 p. 1627 (2002) In the examiner's opinion, this/these claim(s) would have been obvious according to one of the rationales expressed in the *Examination Guidelines for Determining Obviousness Under 35 U.S.C. 103 in View of the Supreme Court Decision in KSR International Co. v. Teleflex Inc.*, as published at 72 Federal Register 57526 et seq. (10/10/2007).

The Guidelines explain that an invention that would have been obvious to a person of ordinary skill at the time of the invention is not patentable. The Guidelines point out that, as reiterated by the Supreme Court in KSR, the framework for the objective analy-

sis for determining obviousness under 35 U.S.C. 103 is stated in *Graham v. John Deere Co.* Obviousness is a question of law based on underlying factual inquiries. The factual inquiries enunciated by the Court are as follows:

(1) Determining the scope and content of the prior art;

(2) Ascertaining the differences between the claimed invention and the prior art, and

(3) Resolving the level of ordinary skill in the pertinent art.

With regard to claims 11, 21 and 28, we begin by considering the first and second factual findings (the third finding concerning the level of skill in the art, is the same as before) required by *Graham*. The scope and content of the prior art includes, in the Ryzhii et al. disclosure, a description of a method of managing terahertz radiation, the method comprising: providing a field effect transistor having a two-dimensional carrier gas and a transparent gate; exciting the carrier gas by shining a laser; and adjusting a frequency of the radiation to a desired frequency using a bias voltage applied to the transparent gate of the field effect transistor; wherein the bias voltage adjusts a carrier density of carriers in a channel of the field effect transistor. Note figure 1 and pages 1875-1876 and 1881 of Ryzhii et al. The difference between the prior art method disclosed by Ryzhii et al. and the method of claims 11, 21, and 28 is that:

1) Where these claims require a step of generating a 1-10,000 femtosecond laser pulse with a laser, Ryzhii et al.'s method includes a step of shining two lasers with a difference frequency. Ryzhii et al. does teach (note the first column of page 1875) that

optical techniques using a coherent output at the difference frequency equal to the difference between the frequencies of radiation emitted by two lasers (as Ryzhii et al. does) or a response of photoconductive structures to femtosecond optical pulses (as is claimed) are, in Ryzhii et al.'s words, "Alternative approaches."

2) Where the claim requires the use of a periodic grating gate, Ryzhii et al.'s method uses a transparent gate.

Sarukura et al. discloses a method of generating radiation including a step of generating a series of 70 femtosecond laser pulses with a laser and shining the laser pulses onto a III-V target. Sarukura et al.'s method produces a tunable THz source in the 0.5–3 THz region by shining a laser onto a III-V semiconductor target. Note figures 2A-2B and the second paragraph of Sarukura et al. Further, Peralta et al. discloses a method of producing voltage-tuned terahertz radiation with a grating-gated field-effect transistor. Note figure 1, the abstract, and the left column of page 1627 of Peralta et al. The question is, taking into account the high level of education, skill, and creativity of one of ordinary skill in the semiconductor art, would it have been obvious to achieve the invention of claims 11, 21, and 28 by substituting the step of step of generating a 70 femtosecond laser pulse with a laser taught by Sarukura et al. for Ryzhii et al.'s step of shining two

lasers with a difference frequency, and by substituting Peralta et al.'s periodic grating gate for Ryzhii et al.'s transparent gate?

To reject a claim based on the basis of the rationale expressed in section IIIB of the *Examination Guidelines*, Office personnel first must resolve the Graham factual inquiries (as has just been done). Office personnel must then articulate the following:

> (1) a finding that the prior art contained a device (method, product, etc.) which differed from the claimed device by the substitution of some components (step, element, etc.) with other components;
>
> (2) a finding that the substituted components and their functions were known in the art;
>
> (3) a finding that one of ordinary skill in the art could have substituted one known element for another, and the results of the substitution would have been predictable; and
>
> (4) whatever additional findings based on the *Graham* factual inquiries may be necessary, in view of the facts of the case under consideration, to explain a conclusion of obviousness.

As explained above, Ryzhii et al. discloses a method that differed from the claimed device only by the substitution of some steps (a step of generating a 70 femtosecond laser pulse with a laser) for other steps (a step of shining two lasers with a difference frequency). Sarukura et al. discloses that the substituted steps and their functions were known in the art. Further, Sarukura et al. discloses that those of skill in the art were familiar with a method combining the step of generating a 70 femtosecond laser pulse with a laser with a method (producing a tunable THz source in the 0.5–3 THz region by shining a laser onto a II-V target) very similar to Ryzhii et al.'s method. From the similarities between Sarukura et al.'s method and Ryzhii et al.'s method, one of skill in the

art would have been able to conclude that the step of generating a 70 femtosecond laser pulse with a laser could have substituted for the step of shining two lasers with a difference frequency of Ryzhii et al.'s method. One of skill in the art would have had reason to predict (based on its functioning in combination with Sarukura et al.'s method) that the step of generating a 70 femtosecond laser pulse with a laser would have continued functioning much as it did in combination with Sarukura et al.'s method, and that after the substitution, Ryzhii et al.'s method would continue functioning in the manner disclosed by Ryzhii et al. It would therefore have been obvious to a person having skill in the art to modify Ryzhii et al.'s method by substituting the step of generating a 70 femtosecond laser pulse with a laser taught by Sarukura et al. for Ryzhii et al.'s step of shining two lasers with a difference frequency.

Further, Ryzhii et al. discloses a method of producing terahertz radiation with a voltage-tuned FET that differed from the FET used in the claimed method by the substitution of some components (a periodic grating gate) with other components (a transparent gate). Peralta et al. discloses that the substituted components and their functions were known in the art. Further, Peralta et al. discloses that those of skill in the art were familiar with a method of combining a periodic grating gate with a field-effect transistor similar to Ryzhii et al.'s field-effect transistor. From the similarities between Peralta et al.'s

field-effect transistor and Ryzhii et al.'s field-effect transistor, one of skill in the art would have been able to conclude that the periodic grating gate could have substituted for the transparent gate of Ryzhii et al.'s field-effect transistor. One of skill in the art would have had reason to predict (based on its functioning in combination with Peralta et al.'s field-effect transistor) that the periodic grating gate would have continued functioning much as it did in combination with Peralta et al.'s field-effect transistor, and that when substituted, Ryzhii et al.'s field-effect transistor would continue functioning in the manner disclosed by Ryzhii et al. It would therefore have been obvious to a person having skill in the art to modify Ryzhii et al.'s method by substituting the periodic grating gate taught by Peralta et al. for Ryzhii et al.'s transparent gate.

C. The Guidelines point out that the both the Graham and KSR decisions require Office personnel to evaluate objective evidence relevant to the issue of obviousness. Such evidence, sometimes referred to as "secondary considerations," may include evidence of commercial success, long-felt but unsolved needs, failure of others, and unexpected results. The evidence may be included in the specification as filed, accompany the application on filing, or be provided in a timely manner at some other point during the prosecution. The weight to be given any objective evidence is decided on a case-by-

case basis. The mere fact that an applicant has presented evidence does not mean that the evidence is dispositive of the issue of obviousness.

For evidence of unexpected results one must rely solely on evidence supplied by Applicants. Applicants have actually made the claimed combination. Evidence of differences between results of the actual functioning of the claimed combination and the results of the functioning one of skill in the art would have had reason to predict (i.e., the “expected results”) must necessarily come from one who has actually made the combination. A clear case of unexpected results would be if the claimed combination of prior art elements did not in fact perform according to their established functions in a predictable fashion; a result sometimes referred to as “synergy.” See *Anderson’s-Black Rock v. Pavement Co*. 396 U.S. 57, 61 (1969) (note that the *Anderson’s-Black Rock* opinion does not actually employ the word “synergy”). However, the Guidelines make it clear that any type of unexpected results (and indeed any type of secondary considerations) must be considered.

Applicants’ specification, however, does not include any evidence of secondary considerations. Applicants disclose that the claimed combination “may be” made; Applicants do not disclose any unexpected results or indeed any results at all.

Allowable Subject Matter

3. Claim 23 is allowable because it specifically requires a 20 femtosecond laser pulse, which is a much (1/3 or less) shorter pulse than the laser pulses used in the prior art to produce terahertz radiation from III-nitride targets.

Response to Arguments

4. Applicant's arguments filed 01/16/2009 have been fully considered but they are not persuasive.

It is argued, at pages 8-9 of the remarks, that “Applicants note that in rejecting the claims, the Office, inter alia, defines the level of ordinary skill as ‘extremely high’, and [to support] its findings, the Office states that ‘[m]any prior art solutions in this field have won Nobel prizes’, and lists several Nobel laureates and notes that there are ‘probably a half dozen more this writer has forgotten.’" Office Action, pp. 4-5. Applicants again note that the presence of several Nobel laureates in a field, such as the semiconductor device industry, is largely irrelevant to a finding of the level of <u>ordinary</u> skill as provided by the MPEP and case law.”

The Examiner is required to make findings relative to the level of skill in the art to which the invention is directed. Factors used to make these findings include (but are not

limited to) (1) "Type of problems encountered in the art;" and (2) "prior art solutions to those problems." In his search for evidence of the type of problems encountered in the semiconductor art and the prior art solutions to those problems, the Examiner (for practical reasons) is forced to rely on documentary evidence. Nobelprize.org, official web site of the Nobel Foundation, has proven to be a reliable source of documentation of prior art solutions to problems encountered in the semiconductor arts. It is not the only source on which the Examiner relies, as may be seen above.

In cases where the Supreme Court considered the obviousness of specific inventions, the Supreme Court made its own citations to documentary evidence of prior art solutions to problems encountered in the specific arts to which those inventions were directed. For example, in *Sakraida*, the Supreme Court cited C. Witt, *Classic Mythology* 119-120 (1883), for a description of a prior art solution to the problem of "mucking out" made by the mythological hero Hercules. *Sakraida v. Ag Pro, Inc.*, 425 U.S. 273, footnote 1 (1976). See also *Graham v. John Deere Co.*, 383 U.S. 1 (1966) (listing prior art solutions to problems in the chisel point plow art); *Anderson's-Black Rock v. Pavement Co.*, 396 U.S. 57 (1969) (prior art solutions to problems in the asphalt paving art); and *KSR International Co.* v. *Teleflex Inc.*, 550 U.S. 398 (2007) (prior art solutions to problems in the pedal mounting art). As Applicants are doubtless aware from their reading of

MPEP § 2141.03, the person of ordinary skill in the art is a hypothetical person who is presumed to have known the *relevant* art at the time of the invention. Hercules's prior art solution to “mucking out” the Augean stables was *relevant* to the *Sakraida* level of skill; U.S. Patent No. 2,493,811's prior art solution to the problem of vibration in chisel point plows was *relevant* to the *Graham* level of skill; and U.S. Patent No. 799,014's radiant heater prior art solution to the problem of the asphalt “cold joint” was *relevant* to the *Anderson's-Black Rock* level of skill. In like vein, Nobel Prize winning (and other) prior art solutions to problems in the semiconductor art are *relevant* to the level of skill in the semiconductor art.

It is noted that no Nobel Prizes have been awarded for prior art solutions to problems relevant to “mucking out”, chisel point plowing, asphalt paving, or pedal mounting. These and other fairly obvious differences (including differences in the "rapidity with which innovations are made", "sophistication of the technology" and "educational level of active workers in the field") between these arts (with which the Supreme Court has experience) and the semiconductor art (with which the Supreme Court has *no* experience) have prompted the Examiner to speculate that the Supreme Court (if called upon) might label the person of ordinary skill in the semiconductor art (relatively speaking, and purely for convenience) a person of <u>extraordinary</u> creativity.

It is argued, at page 10 of the remarks, that "[W]hether or not a Nobel prize is awarded in a given field is irrelevant to the level of ordinary skill of those individuals practicing in the given field." However, the basic equations describing the "transistor effect" in the Walter H. Brattain Nobel Lecture (http://nobelprize.org/nobel_prizes/physics/laureates/1956/brattain-lecture.pdf) are reproduced in (for example) S. M. Sze, *Physics of Semiconductor Devices*, John Wiley & Sons, New York, 1969; and Muller & Kamins, *Device Electronics for Integrated Circuits*, John Wiley & Sons, New York, 1977. These and similar textbooks have been required reading in semiconductor courses, at both the undergraduate and graduate levels, for thirty years or more. Note that MPEP 2141.03's fifth factor is "educational level of active workers in the field". It is clear that the educational level of workers in the semiconductor art includes an understanding of Brattain's Nobel Prizewinning discovery, as well as the prior art solutions to semiconductor art problems made by other Nobel Prize winners.

Further, one should keep in mind that what is important is the level of skill required to discern the modification required to reach the claimed invention. Ryzhii et al. teach the use of two laser beams with frequencies Ω1 and Ω2 whose difference is equal to ω, so that the total incident photon flux intensity is modulated can be presented as $I = I_0 + I_\omega \exp(-i\omega t)$, Ryzhii et al., page 1876, column 2, last paragraph. This amounts to a regu-

lar (sinusoidal) rise and fall of the light intensity. Sarukura et al. teach the use of a single laser beam modulated to provide a regular rise and fall of intensity, but with a signal whose regular rise and fall takes the form of a peak pulse. Sarukura et al., page 63, column 1, last paragraph. The level of skill required to reach the claimed invention is the level of skill required to recognize the similarities between the intensity modulation provided by Ryzhii et al.'s twin lasers and the intensity modulation provided by Sarukura et al.'s pulse-modulated laser. Although the ability to recognize these similarities may be beyond one of ordinary skill in the "mucking out", chisel point plow, asphalt paving, or pedal mounting arts, the law is clear that this is irrelevant. The only relevant question is whether one of skill in the semiconductor art ("the art to which said subject matter pertains", see 35 USC § 103) would recognize these similarities.

It is argued, at page 11 of the remarks, that "Applicants note that the method of Ryzhii also differs from the method of claim 1 in that Ryzhii uses two laser beams, or continuous wave lasers, whereas the method of claim 1 uses a laser pulse generated by a laser." However, Ryzhii point out (note page 1876, column 2, last paragraph) that the two laser beams with a difference frequency produces a time-modulated intensity that rises and falls, just as the intensity of a repeatedly applied pulse rises and falls.

It is argued, at page 12 of the remarks, that “Applicants note that Sarukura fails to teach or suggest exciting a carrier gas by generating a laser pulse with a laser and shining the laser pulse directly onto a semiconducting device having a two-dimensional carrier gas as in claim 1.” However, the series of steps Applicant cites Sarukura as lacking amount to 5 of the 7 steps recited in claim 1. As the Examiner points out above, all but one of the steps Applicant cites Sarukura as lacking are in fact taught by Ryzhii. In response to applicant's arguments against Sarukura individually, please note that it has been held that one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

It is argued, at page 13 of the remarks, that “Further, the Office alleges that Sarukura's method is ‘very similar to Ryzhii et al.'s method.’ However, as discussed during the telephone interview, Applicants note that apart from the generation of THz radiation and use of an As-based emitter, little to nothing is similar between the methods disclosed in Ryzhii and Sarukura.” Applicant is correct. The only similarities between Sarukura's and Ryzhii et al.'s methods is the use of laser light having rising and falling intensity to generate THz radiation using an As-based emitter. On these facts, one may con-

clude that the two methods are more similar to each other than either is to (for example) Sakraida's "mucking out" method. Whether this makes Ryzhii's and Sarukura's methods "very" similar may be open to debate. Would Applicant be willing to accept the characterization "palpably similar"? One thing seems apparent: the periodically rising and falling laser intensity provided by Sarukura's periodically pulsed laser is similar to the periodically rising and falling laser intensity provided by Ryzhii et al.'s pair of lasers with a difference frequency.

It is argued, at page 14 of the remarks, that "For example, rather than merely substituting one known element for another as alleged by the Office, the Office is proposing to replace the two continuous wave lasers of Ryzhii with the series of laser pulses of Sarukura. Applicants note that such a substitution is not a substitution of two alternative elements, each of which performs the same function. To the contrary, the series of laser pulses of Sarukura is clearly distinct from the two continuous wave lasers of Ryzhii."

It is very surprising to the Examiner that Applicants Ryzhii and Shur would agree to imply that the "two laser beams with a difference frequency" of the Ryzhii reference supplied two independent light signals to the two-dimensional carrier gas. In the Ryzhii reference, these Applicants (as authors) correctly pointed out the fact that the coherent light waves produced by these lasers actually interfere with one another to produce a

total incident photon flux that rises and fell in intensity as $I = I_0 + I_\omega exp(-i\omega t)$, Ryzhii et al., page 1876, column 2, last paragraph. It seems intellectually dishonest for these scientists (each of whom holds a Ph.D. and has authored numerous rigorously correct scientific papers) to now imply a different result.

It is argued, at page 15 of the remarks, that "Still further, the Office's proposed substitution of the series of laser pulses of Sarukura for the two continuous wave lasers of Ryzhii impacts the operation of another component of the Ryzhii system, namely, the quantum well structure. In particular, in Ryzhii, the quantum well structure generates electromagnetic radiation as a direct result of irradiation from the two continuous wave lasers. By proposing to replace the two continuous wave lasers with the series of laser pulses of Sarukura, the Office is substantially altering how the quantum well structure is irradiated. Applicants submit that such an alteration makes any result of the Office's proposed substitution unpredictable, without benefit of the hindsight of Applicants' disclosure." Here Applicants once again characterize Ryzhii's step of shining two lasers with a difference frequency in such a way that one assumes (on the basis of Applicants' characterization) that Ryzhii's two lasers supply independent signals to the quantum well structure. However, Ryzhii, Shur, and their co-author Irina Khmyrova made it abundantly clear that the only reason for using two lasers with a difference frequency was to

apply to the quantum well a light-wavelength signal whose intensity rose and fell regularly.

It is argued, at page 16 of the remarks, that “In stating that 35 U.S.C. 103 does ‘not seem to require that the combination produce any particular result,’ the Office appears to allege that an expectation of the particular result of the proposed combination is not required to be shown.” This is not the Office’s allegation; it is one of the explicit holdings of *KSR*. “The first error of the Court of Appeals in this case was to foreclose this reasoning by holding that courts and patent examiners should look only to the problem the patentee was trying to solve.” *KSR International Co. v. Teleflex Inc.*, 550 U.S. __, 82 USPQ2d 1385, 1391 (2007), as cited in the *Examination Guidelines for Determining Obviousness Under 35 U.S.C. 103 in View of the Supreme Court Decision in KSR International Co. v. Teleflex Inc.*, 72 Federal Register 57526, column 3.

It is argued, at page 17 of the remarks, that “Additionally, to the extent that the Office alleges that it is enough that the laser generating the series of laser pulses in Sarukura would continue to operate in the same manner in the Office's proposed combination, Applicants respectfully submit that this is insufficient to present a prima facie showing of obviousness. As discussed above, Applicants respectfully submit that the Office ignores the impact that the Office's proposed substitution will have on the operation of the quan-

tum well structure of Ryzhii. In particular, by making the proposed substitution, the Office is substantially altering how the quantum well structure is irradiated." Applicants' statement, "making the proposed substitution, the Office is substantially altering how the quantum well structure is irradiated", is not supported by the facts. Ryzhii et al. teach irradiating the quantum well structure with light intensity that rises and falls periodically as $I = I_0 + I_\omega \exp(-i\omega t)$. Sarukura et al. teach supplying a light intensity that rises and falls periodically (at an 80 MHz rate), but rises and falls rapidly enough so that a series of 70 fs pulses is produced. In the proposed substitution, Sarukura et al.'s pulse-modulated laser will continue to operate exactly as it did in combination with Sarukura et al.'s THz generating device. Further, Ryzhii et al.'s quantum well structure will continue to operate exactly as it did while being irradiated by the rising and falling intensity produced by Ryzhii et al.'s two lasers with a difference frequency.

It is argued, at page 18 of the remarks, that "With further respect to claim 16, Applicants submit that the Office fails, inter alia, to show that the proposed combination of Ryzhii and Sarukura teaches or suggests adjusting the frequency of the radiation by using a plurality of heterodimensional diodes as in claim 16. Applicants note that Ryzhii and Sarukura both fail to teach the use of a plurality of heterodimensional diodes, let alone using the plurality of heterodimensional diodes to adjust the frequency of the ra-

diation as in claim 16. Further, the Office does not allege that either Ryzhii or Sarukura teaches such a feature."

The strength of Applicant's argument depends on the proper interpretation of the claim term "plurality of heterodimensional diodes". Patent claims construed during reexamination should be given their broadest reasonable interpretation consistent with specification, and should be read in light of specification as it would be interpreted by person of skill in art, since this policy serves public interest by reducing possibility that claims, finally allowed, will be given broader scope than is justified (*In re American Academy of Science Tech Center*, 70 USPQ2d 1827, Decided May 13, 2004). See MPEP §2111. Keeping this maxim in mind, the Examiner has interpreted "heterodimensional diode" as a diode formed between a semiconductor having a narrow bandgap and another semiconductor having a wide bandgap. A "plurality of heterodimensional diodes", in its simplest incarnation, would be two such diodes. Ryzhii et al. show a plurality of diodes formed between narrow and wide bandgap materials, as may be seen at 1877-1878.

Conclusion

5. THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas L. Dickey whose telephone number is 571-272-1913. The examiner can normally be reached on Monday-Thursday 8-6.

If attempts to reach the examiner by telephone are unsuccessful, please contact the examiner's supervisor, Sue A. Purvis, at 571-272-1236. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the

PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Thomas L. Dickey/
Primary Examiner
Art Unit 2826